

A Pro Active Approach to Construction Safety Management at NASA's Jet Propulsion Laboratory (JPL)

Jeff Behar, MS, MBA, CIH
Barron J. Peeler, MPH, CAC

Jet Propulsion Laboratory, California Institute of Technology.



Disclaimer

Herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not constitute or imply its endorsement by the United States Government or the Jet Propulsion Laboratory, California Institute of Technology. If this presentation is to be published or distributed the copyright statement must be added. Add: Copyright 2017 California Institute of Technology. U.S. Government sponsorship acknowledged.

NASA's OSMA's Structure and Culture

- NASA's Office of Safety and Mission Assurance (OSMA) assures the safety and enhances the success of all NASA activities
- OSMA includes the Mission Support Division, Safety and Assurance Requirements Division, and NASA Safety Center
- OSMA sets safety and health policy and requirements that flows down to JPL
- Construction Safety and fall protection falls under OSMA
- NASA prime contract identifies minimum safety requirements

Aviation Safety

Construction Safety and Fall Protection

EEE Parts

Electrical Safety

ELV Payload Safety

Facility System Safety

Fire Protection

GIDEP

Institutional Safety

Lifting Devices and Equipment

Meteoroid Environments

Metrology and Calibration

Mishap Investigation

Nondestructive Evaluation

Nuclear Flight Safety

NSRS

Orbital Debris

Pressure Vessels and Systems

Quality

Range Flight Safety

Reliability and Maintainability

Risk Management

Safety Culture

SMSR

Software Assurance

System Safety

Workmanship



JPL's OSMS Structure and Culture

- JPL's Office of Safety and Mission Success (OSMS)
- OSMS is an independent organization reporting to the JPL Director
- Occupational Safety Program Office (OSPO) is in the OSMS Directorate and is the organization that implements the construction safety program at JPL
- Unique culture bigger than basic occupational safety drives safety at JPL



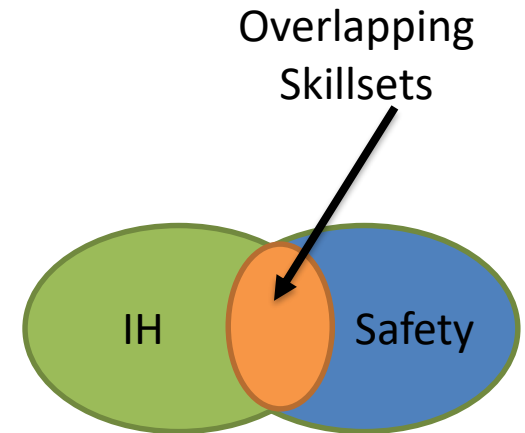
JPL Facts

- JPL is a unique national research facility that carries out robotic space and Earth science missions
- JPL is a federally funded research and development center managed for NASA by Caltech
- Our purpose unmanned space exploration
- JPL Outsources:
 - Operations and maintenance
- Multi-employer environment
- NASA ensures we are effective by requiring regular accountability
 - NASA Contract flow-downs



Why is Understanding Construction Safety Beneficial to an IH and How can JPL's Approach to Construction Safety Benefit an IH?

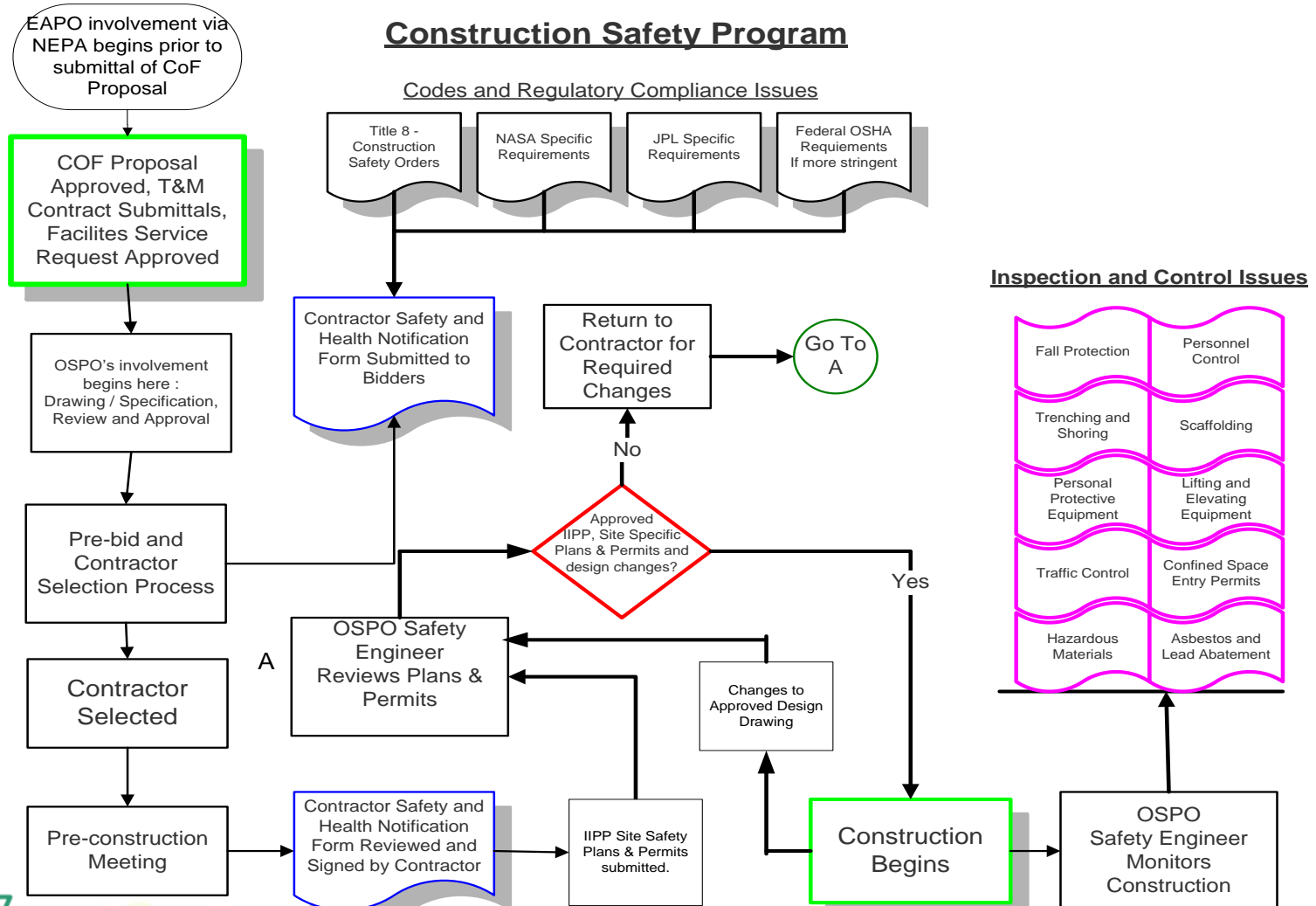
- Construction safety includes many IH issues
 - CSE
 - Noise
 - Particulate exposure
 - Welding (UV, Chromium,. Etc.)
 - Heat stress
 - Asbestos/Lead
 - Additive Manufacturing
- There is overlap
- IH's bring a unique valued perspective to construction safety
- Understanding both makes you a more valued professional
- JPL's Proactive approach of merging IH and Safety into the lifecycle of each construction project has been successful



Team Approach for Construction Safety at JPL


- The construction safety program leverages the talent and support of the following organizations:
 - Occupational Safety Program Office (OSPO)
 - Acquisition Division
 - Systems Safety Program Office
 - Environmental Affairs Program Office (EAPO)
 - Facilities Division
 - Fire Life Safety Authority Having Jurisdiction (AHJ)
 - Electrical AHJ
- Key organizations are involved throughout the lifecycle of the project - from project development to certificate of occupancy.

JPL's Construction Safety Program Process Flow



Project Design Reviews

- Project design drawings are reviewed by the following disciplines:
 - Fire/Life Safety
 - Electrical Safety
 - Mechanical Systems
 - Construction Safety
 - Environmental
 - Other Subject Matter Experts (SMEs) are called in as the project needs dictate
 - Pressure Systems
 - Ventilation
 - Asbestos

<h2 style="margin: 0;">SOLAR ELECTRIC SYSTEM</h2> <h3 style="margin: 0;">NASA JPL BUILDING 301 - PASADENA, CA</h3> <p style="margin: 0;">4800 Oak Grove Dr, Pasadena, CA 91109</p>		<div style="display: flex; justify-content: space-between;"> <div> <p>SECURITY MAP</p>  </div> <div> <p>PROPOSED PROJECT SITE</p> </div> </div>	
<p>GENERAL NOTES:</p> <p>1. ALL WORK SHALL BE IN ACCORDANCE WITH THE LATEST EDITIONS OF THE CALIFORNIA ELECTRICAL CODE, THE NATIONAL ELECTRICAL CODE, AND THE NATIONAL FIRE PROTECTION ASSOCIATION (NFPA) 70B RECOMMENDATIONS FOR SAFE WORKING PRACTICES.</p> <p>2. THE CONTRACTOR SHALL BE RESPONSIBLE FOR OBTAINING ALL NECESSARY PERMITS AND APPROVALS FROM THE PASADENA CITY ENGINEERING DEPARTMENT AND THE CALIFORNIA DEPARTMENT OF INDUSTRIAL RELATIONS (DIR).</p> <p>3. THE CONTRACTOR SHALL MAINTAIN ACCESS TO ALL ADJACENT PROPERTIES AND UTILITIES AT ALL TIMES.</p> <p>4. ALL MATERIALS AND EQUIPMENT SHALL BE STORED IN AN SECURE AND ACCESSIBLE MANNER.</p> <p>5. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE PROTECTION OF ALL EXISTING UTILITIES AND STRUCTURES.</p> <p>6. ALL WORK SHALL BE COMPLETED WITHIN THE SPECIFIED TIME FRAME.</p> <p>7. THE CONTRACTOR SHALL MAINTAIN A NEAT AND ORDERLY WORK SITE AT ALL TIMES.</p> <p>8. ALL WORK SHALL BE COMPLETED IN ACCORDANCE WITH THE PROJECT SPECIFICATIONS AND DRAWINGS.</p> <p>9. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE PROTECTION OF ALL EXISTING UTILITIES AND STRUCTURES.</p> <p>10. ALL WORK SHALL BE COMPLETED WITHIN THE SPECIFIED TIME FRAME.</p>		<p>SCOPE OF WORK:</p> <p>1. INSTALLATION OF SOLAR PANELS ON THE ROOF OF BUILDING 301.</p> <p>2. ELECTRICAL WIRING AND CONNECTIONS TO THE BUILDING'S ELECTRICAL SYSTEM.</p> <p>3. MOUNTING RAIL INSTALLATION AND ADJUSTMENT.</p> <p>4. PERMITTING AND INSPECTION COORDINATION.</p> <p>5. MATERIALS AND EQUIPMENT DELIVERY AND STORAGE.</p> <p>6. SITE PREPARATION AND CLEANUP.</p> <p>7. TRAINING AND DOCUMENTATION FOR OPERATORS.</p> <p>8. FINAL INSPECTION AND COMPLETION REPORT.</p>	
<p>ADDITIONAL COMMENTS PERTAINING TO SUBMITTALS ONLY:</p>		<p>APPROVALS:</p> <p>_____ Project Manager</p> <p>_____ Client Representative</p> <p>_____ Inspector</p>	
<p>PROJECT INFORMATION:</p> <p>Project Name: Solar Electric System Installation</p> <p>Location: NASA JPL Building 301, Pasadena, CA</p> <p>Client: NASA Jet Propulsion Laboratory</p> <p>Contract Number: JPL-2023-001</p> <p>Start Date: 01/15/2024</p> <p>End Date: 03/31/2024</p>		<p>CONTACT INFORMATION:</p> <p>Project Manager: [Name], [Phone], [Email]</p> <p>Client Representative: [Name], [Phone], [Email]</p> <p>Inspector: [Name], [Phone], [Email]</p>	
<p>PROJECT SPECIFICATIONS:</p> <p>1. SOLAR PANELS: MONOCRYSTALLINE SILICON, 330W PER PANEL.</p> <p>2. MOUNTING RAILS: ALUMINUM, TILT ADJUSTABLE.</p> <p>3. ELECTRICAL WIRING: 12 AWG CU, THHN/THWN-2.</p> <p>4. CONDUIT: 1/2" EMT, GALVANNEED STEEL.</p> <p>5. CABLE TRAYS: ALUMINUM, 12" WIDE.</p> <p>6. JUNCTION BOXES: UL LISTED, 1/2" NPT.</p> <p>7. BREAKERS: 20A, 250V, UL LISTED.</p> <p>8. FUSES: 20A, 250V, UL LISTED.</p> <p>9. GROUNDING: 4 AWG CU, GROUNDING BUS.</p> <p>10. LABELING: ALL WIRING AND EQUIPMENT TO BE PROPERLY LABELED.</p>		<p>PROJECT SCHEDULE:</p> <p>Task: [Task Name], Duration: [Days], Start: [Date], End: [Date]</p> <p>Task: [Task Name], Duration: [Days], Start: [Date], End: [Date]</p> <p>Task: [Task Name], Duration: [Days], Start: [Date], End: [Date]</p>	
<p>PROJECT TEAM:</p> <p>Project Manager: [Name]</p> <p>Client Representative: [Name]</p> <p>Inspector: [Name]</p> <p>Electrician: [Name]</p> <p>Installer: [Name]</p>		<p>PROJECT BUDGET:</p> <p>Item: [Item Name], Quantity: [Qty], Unit Price: [Price], Total: [Total]</p> <p>Item: [Item Name], Quantity: [Qty], Unit Price: [Price], Total: [Total]</p> <p>Item: [Item Name], Quantity: [Qty], Unit Price: [Price], Total: [Total]</p>	
<p>PROJECT RISK ASSESSMENT:</p> <p>Risk: [Risk Name], Severity: [Level], Likelihood: [Level], Mitigation: [Action]</p> <p>Risk: [Risk Name], Severity: [Level], Likelihood: [Level], Mitigation: [Action]</p> <p>Risk: [Risk Name], Severity: [Level], Likelihood: [Level], Mitigation: [Action]</p>		<p>PROJECT CHANGE LOG:</p> <p>Change: [Change Description], Date: [Date], Status: [Status]</p> <p>Change: [Change Description], Date: [Date], Status: [Status]</p> <p>Change: [Change Description], Date: [Date], Status: [Status]</p>	
<p>PROJECT DELIVERABLES:</p> <p>Deliverable: [Deliverable Name], Status: [Status], Due Date: [Date]</p> <p>Deliverable: [Deliverable Name], Status: [Status], Due Date: [Date]</p> <p>Deliverable: [Deliverable Name], Status: [Status], Due Date: [Date]</p>		<p>PROJECT CLOSEOUT:</p> <p>Final Inspection: [Date], Status: [Status]</p> <p>Client Acceptance: [Date], Status: [Status]</p> <p>Project Completion: [Date], Status: [Status]</p>	

Fixed Price Construction Projects

- 99% of our Fixed Price Construction contracts follow these three phases:
 - Solicitation
 - Notice of Award (NOA)
 - Notice to Proceed (NTP)
- These phases are in line with Federal Acquisition Regulations

Pre-bid Documentation

- Safety documentation included with bid packages:
 - Additional General Provisions (terms and conditions) Safety and Health Special Conditions
 - 2885 Form - Contractor Safety & Health Notification (incorporates NASA Safety and Health Contract Requirements)
 - A-100 (Requirements for asbestos abatement work)
 - A-200 (Requirements for class 3 asbestos work)
- Covers
 - Cal/OSHA Title 8, Fed/OSHA, JPL and NASA specific safety and health requirements

Pre-construction Meetings

- Key JPL Departments present:
 - Facilities
 - Occupational Safety Program Office (OSPO)
 - Acquisitions
 - Fire/Life Safety AHJ
 - Electrical Safety AHJ
 - Security
 - Fire Department
 - Environmental Affairs Program Office (EAPO)
- Purpose of this meeting is to outline project, safety and security requirements and clarify any questions contractor may have while working at JPL.

Contractors' Safety Submittal Review Process

- Injury & Illness Prevention Program (IIPP)
- Site Specific Safety Plan (SSSP)
- Experience Modification Rate (EMR)
- Asbestos & Lead Work Plans
- Fall Protection Plans
- Scaffold Safety Plans
- Lift Plans
- Training certifications
- OSPO notifies Acquisitions when all documents are accepted
 - Notice to Proceed (NTP) Issued by Acquisitions

Safety Management Tools


JPL Propulsion Laboratory
California Institute of Technology
4800 Oak Grove Drive
Pasadena, California 91109-8099
(610) 354-4221

JPL

Activity Report

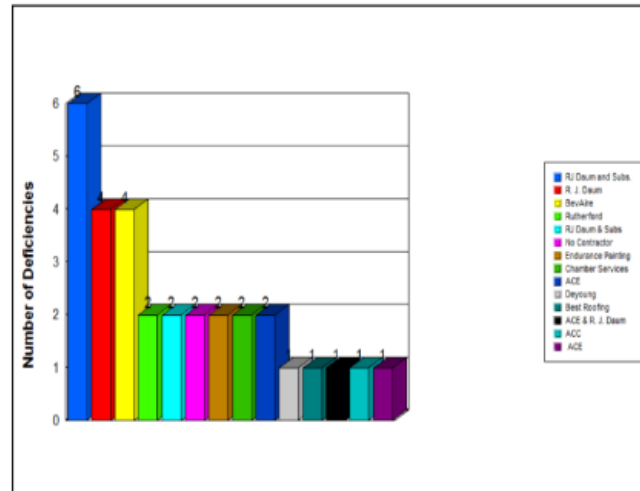
Area Inspected: 00230 - 230-EXT Inspection: 016000
Completed on: Wednesday, February 10, 2016

Inspector: JEFFREY BLUM (100394) Contractor: ACE
Activity: Construction Safety Contractor: Rubenford

	
L. CHEMICAL AND ENVIRONMENT	Pass MSDS on file.
M. FIRE PROTECTION	Pass Portable fire extinguishers inspected monthly per Cal/OSHA Title 8 §1022. Portable Fire Fighting Equipment. (a) (4).
M. FIRE PROTECTION	Pass

JPL

Inspection / CAR Statistics Report by Contractor 01/01/2016 - 03/31/2016



Thursday, March 31, 2016

DECEMBER HOLIDAY EDITION

JPL SAFETY NOTES

Contractor Safety Observations at JPL Safety Reminders when Working at JPL

- Contractor using power tools without eye protection and without hearing protection.
 - Contractor not properly segregating work area from passerbys.
 - Roofing contractor incorrectly using portable anchor system (too much slack in rope grab) exposing employees to a 20' fall.
 - Two employees working near unguarded floor opening on 2nd floor of a building.
 - Contractor table saw operating without guard.
 - Circular saw guard improperly set (too much distance between guard and blade).
 - Contractor daisy chaining extension cords (cords plugged into one another).
 - Contractor using temporary power cords as permanent wiring.
 - Contractor employees unaware of MSDS/SDS and their location.
 - Contractor improperly running extension cords through walls.
 - Contractor storing flammable materials under a stairwell without sprinklers.
 - Extension cords not properly hung, creating a tripping hazards and a violation to the Cal/OSHA electrical code.
 - Contractor connecting power strips in series to power table saw.
 - Contractor's fire extinguisher discharged. Also missing annual certification, monthly inspection tag, and was too small for the work area.
 - Two men using a ladder designed for one.
- Reporting Safety Hazards**
- Emergency Contacts**
- JPL Landline: 911
 - Cell phone: 818-393-3333 or 818-354-3333
- Mishap and Hazard Reporting**
- Report all mishaps to your supervisor immediately.
 - Immediate Mishap and Close Call (IMACC) Reporting Line: 818-354-2141 (call this number to report injuries, close calls)
 - Anon. Hazard Reporting Hotline: 818-393-6483
 - NASA Safety Reporting System (NSRS): <http://www.hq.nasa.gov/office/code/nsrs/index.htm>
- Non-Emergency Contacts**
- Occupational Safety Program Office: 818-354-4711
 - JPL Construction Safety Contact (Jeff Behar): (818) 354-8042 (office), (618) 235-8787 (mobile)
 - JPL Facilities Safety Contact (Barron Poeler): (818) 354-4280 (office), (628) 923-7695 (mobile)
 - Environmental Affairs (spills): 818-354-0180
- Holiday Chuckle**
- Know your evacuation route and rendezvous point.
- Keep your work and storage areas clean. Pledge daily.
 - Do NOT use extension cords or power strips in series.
 - Segregate your work area from others.
 - Review Safety Data Sheets before using any chemicals.
 - All chemicals to be used at JPL must be preapproved.
 - Wear eye protection when performing ANY task that can result in injury to your eyes, this includes cutting, grinding, sweeping debris, etc.
 - Obeys traffic signs throughout JPL.
 - Fall protection must be worn whenever you are exposed to a fall hazard of 6 feet or greater.
 - All users of fall protection must be trained. A fall protection plan must be in place to wear fall protection equipment at JPL.
 - If you have not already review JPL's Contractor Safety Awareness Video before starting work at JPL, can be accessed at: <https://acquisition.jpl.nasa.gov/c/supdoc/>
 - Contractor shall provide 24-hour advance notice to the JPL Construction Administrator prior to scheduling entry into a confined space.
 - For the purposes of lockout/tagout/blockout, only red padlocks shall be used at JPL.
 - A JPL Excavation Permit must be obtained from the JPL Construction Administrator prior to any digging operation (except for hand digging <12").
 - An approved JPL Lift Permit must be obtained prior to any mobile lifting or elevating operation.
 - A hot work permit must be obtained from the Construction Administrator prior to any hot work (e.g. welding, cutting, or other ignition source).
 - Review your company's site specific safety plan prior to starting work at JPL.



Project Completion Acceptance Process

- Project Acceptance (work performed has met contract requirements) includes:
 - Review of contract /work scope vs. work performed
 - Submission of applicable required documents:
 - As Built Drawings,
 - Equipment submittals,
 - Operating manuals,
 - Inspection reports, and
 - Commissioning report
 - Training of staff
 - required when a project includes installation of equipment requiring maintenance (such as cooling towers, chillers, etc..).

FINAL COMMISSIONING TOWER INSPECTION REPORT																																																																																						
DATE: _____		STR NO. _____				STR TYPE: _____																																																																																
CIVIL WORKS																																																																																						
						DEFLECTION																																																																																
Rotation $\pm 0^\circ 40'$ Centre Position $\pm 100\text{mm}$						Acceptable <input type="checkbox"/> Not Acceptable <input type="checkbox"/>		Piling Log Base Elevations- Level Cathodic Protection complete <input type="checkbox"/>																																																																														
FRAMING WORKS																																																																																						
Bolt torques checked <input type="checkbox"/> Bent or missing members/webbing <input type="checkbox"/> Bolts in and down <input type="checkbox"/> Aerial Markers installed <input type="checkbox"/> Tower name plate installed <input type="checkbox"/>						Acceptable <input type="checkbox"/> Not Acceptable <input type="checkbox"/>		Remarks: _____																																																																														
CONDUCTOR / ACCESSORIES																																																																																						
Accepted <input type="checkbox"/> Not Accepted <input type="checkbox"/>						SIDE _____ SIDE _____		Remarks: _____																																																																														
Insulators plumb $\pm 50\text{ mm}$ Yoke Plates $\pm 50\text{ mm}$ Keys/bolts in & down <input type="checkbox"/> Keeper Keys in <input type="checkbox"/> Insulator damage/ correct <input type="checkbox"/> Dampers correct <input type="checkbox"/> Conductor (damage) <input type="checkbox"/> Hardware <input type="checkbox"/> Deadends Splices installed properly <input type="checkbox"/> Corona coils <input type="checkbox"/> Bird caging <input type="checkbox"/> Jumpers <input type="checkbox"/>						<table border="1"> <thead> <tr> <th></th> <th>Top</th> <th>Center</th> <th>Bottom</th> <th>Top</th> <th>Center</th> <th>Bottom</th> </tr> </thead> <tbody> <tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr> </tbody> </table>			Top	Center	Bottom	Top	Center	Bottom																																																																							Trip Grds Still installed <input type="checkbox"/> YES	
	Top	Center	Bottom	Top	Center	Bottom																																																																																
SAG AND TENSION																																																																																						
Ground Clearance <input type="checkbox"/> Sags <input type="checkbox"/>						Accepted <input type="checkbox"/> Not Accepted <input type="checkbox"/>		Measurements _____ Temp _____ Wind _____																																																																														
OPGW / OHSW																																																																																						
OPGW dampers <input type="checkbox"/> OPGW clipped <input type="checkbox"/> OPGW Hardware <input type="checkbox"/> Keys in Yes <input type="checkbox"/> No <input type="checkbox"/>						Accepted <input type="checkbox"/> Not Accepted <input type="checkbox"/>		OPGW Ground connection <input type="checkbox"/> OPGW junction box + access <input type="checkbox"/>																																																																														
R.O.W & ACCESS																																																																																						
Site cleanup <input type="checkbox"/> Ground work <input type="checkbox"/> Outstanding danger trees <input type="checkbox"/>						Accepted <input type="checkbox"/> Not Accepted <input type="checkbox"/>		Remarks: _____																																																																														
COMMENTS: _____																																																																																						

Certificate of Occupancy (CO) Process

- This process involves JPL's Authority Having Jurisdiction (AHJ) functioning as an internal "building department" issuing a certificate of occupancy (CO) after the work has been approved
- The CO process includes:
 - Project walk
 - Completing/Inspecting/ Testing of life safety protection systems and electrical components by AHJs
 - Review of final drawings against applicable building and fire life safety codes
 - Standard and Compliance Group within the Facilities Section issues the CO for signature by AHJs



Small Time & Material Tasks/ Projects

- These are usually tasks rather than projects
- Typically no design review
- Typically no pre-construction meeting
- Time & Materials contractors are used
- These projects are spot audited for safety compliance
- These projects are very important to JPL's and NASA's overall mission because they provide working facilities where research, project support and project management for space missions are performed



Repurposing of Space Projects

- Remodeling and repurposing spaces:
 - Laboratory redesign
 - Office remodels
 - Clean room reconstruction
 - Electrical and mechanical upgrades to meet research and project needs
 - Modular office
- Other
 - Hardscape work
 - ADA upgrades
 - Road work
 - Roofing jobs



Large Construction Project Examples



B212 Anechoic Chamber

- This \$1.4M project included:
 - The reconfiguration of the Spacecraft Antennas Group building's ceiling, concrete foundation, steel erection, wall finishes, electrical, and lighting fixtures
 - Abatement of lead containing paint from structural members
 - Upgrade of the chamber crane system
 - Upgrade of the fire protection system
 - Replacement of radio frequency (RF) absorbing material in Anechoic chamber
- IH and Safety Engineering Challenges
 - Remote location
 - Project restrictions due to RF testing
 - Confined space entry issues
 - Roof work/fall protection issues
 - Lead issues



Space Flight Operations Facility (SFOF) Upgrade Project

- SFOF is our Mission Control Center
- Monitors and controlled all interplanetary and deep space exploration
- Operates 24/7
- National Historic landmark
- NASA's Deep space Network (DSN) currently operated from this facility
- SFOF is mission critical
- Construction work to this facility has to be carefully planned and executed



Space Flight Operation Center Data Center Upgrade

- The data Center Project included:
 - Asbestos/lead abatement
 - Demolition
 - Subsurface work
 - Mechanical system upgrade
 - Electrical system upgrade
 - New building addition
- Challenges
 - Building is the main mission control station for critical space operations



West Arroyo Parking Structure (WAPS)

- The \$17.5 million Project included:
 - The construction of new five-story, 1,500-stall, cast-in-place and post-tension 460,000-square-foot parking structure, concrete parking structure
 - Building relocation
 - Trenching
 - Road widening and hardscape improvements
 - 19 deck and five slab-on-grade pours
 - Steel, formwork, concrete finishing
- Challenges
 - Limited work area
 - Existing utility service lines ran the length of the 900-foot long parking structure's planned footprint, which conflicted with the new foundations
 - Relocation of electrical, sewer, water, storm, communications, natural gas, and compressed air lines
 - Fall protection issues



West Arroyo Parking Structure (WAPS)

- The project included 48 subcontractors and had a remarkable safety record, compiling over 105,000 man hours (equivalent to 13,125 days) without a lost-time injury



Defining Construction Project Success at JPL

- At JPL we consider a successful project if:
 - There are no recordable/lost time injuries or near misses
 - At JPL we have had no OSHA recordable construction related cases within the past 5 years
 - Our O&M Contractor >3300 days without a lost time incident
 - Any observed safety issues immediately corrected
 - Observed safety issues not repeated
 - Project meets schedule and budget
 - Quality meets expectations
 - Contractor(s) part of the “Team”
 - Contractor makes \$ and wants to work at JPL again
 - Project does not impact mission critical operations
- How does your Company define construction project success?